

INTERNALLY ADJUSTABLE BRAKE FOR BAITCAST REEL

FIELD OF THE INVENTION

[0001] The present invention relates to braking systems for fishing reels. More particularly, but not by way of limitation, the present invention relates to adjustable, centrifugal braking systems for baitcast fishing reels.

BACKGROUND OF THE INVENTION

[0002] Baitcast fishing reels are well known in the art. A baitcasting reel typically includes a split frame having a pair of opposing side plates, a foot extending from the frame for attaching the reel to a fishing rod, and a line spool rotatably positioned between the frame side plates for retrieving and holding a fishing line. A spool shaft, on which the spool is secured, has ends extending through the frame side plates. A pinion gear (typically a helical gear) is provided on the spool shaft. A manually rotatable crank handle drives a gear train and crankshaft assembly mechanically linking the crank handle to the spool shaft pinion gear. A level-wind mechanism transverses the spool during winding to ensure that the fishing line is properly wound along the length of the spool. An anti-reverse mechanism is provided for preventing reverse rotation of the crank handle and spool. A clutch mechanism disengages the pinion gear from the spool shaft to allow the spool to rotate

freely during casting and an exterior actuator (typically a thumb lever) engages the clutch. A spool drag or spool braking mechanism is also provided.

[0003] In most cases, right and left side covers are removably attached to the frame side plates for housing various operating mechanisms of the reel. A right-handed baitcasting reel (i.e., a reel designed for a right-handed user) will typically be structured such that the spool drag or spool braking mechanism is housed under the left side cover. The crank handle is rotatably mounted outside of the right side cover and the crankshaft, gear train, pinion gear, clutch, and anti-reverse mechanism are housed under the right side cover. As will be understood by those skilled in the art, a left-handed version of generally any baitcasting reel can be produced by simply reversing the arrangement and structure of the reel's components such that the left-handed reel is a mirror image of the right-handed version of the reel.

[0004] Two basic styles of reels dominate the baitcasting market. One type consists of traditional baitcasting reels having high, round profiles. The other type consists of low profile, contemporary reels having teardrop or generally oval shapes. As used herein, the term "high profile" refers to a reel profile wherein the spacing of the top of the reel above the top of the rod is relatively high, when the reel is secured to a fishing rod. The term "low profile," as used herein, refers to a reel profile wherein the spacing of the top of the reel above the top of the rod is relatively low.

[0005] The low profile nature of the contemporary baitcasting reel desirably allows the user to "palm" the reel during winding. When palming the fishing reel, the user positions one hand around both the reel and the rod and turns the crank handle with the other hand. Many users find that holding the rod and reel in this manner provides comfort and balance. While palming the reel, the user will also typically hold the fishing line such that, during winding, the line passes between the thumb and the forefinger of the palming hand. Thus, palming also serves to remove moisture from the line and, by maintaining a desirable amount of tension on the line, promotes efficient winding.

[0006] Spool drag or spool braking systems are commonly used in baitcasting reels to alleviate line backlashing (also referred to as "line nesting") problems. Because baitcasting reels utilize transversely-oriented spools, which rotate during casting, baitcasting reels are more prone to backlashing problems than are spinning reels and spin-casting reels. Backlashing problems result primarily from the rotational momentum carried by the spool. The most common types of drag/braking mechanisms used in baitcasting reels are magnetic drag systems and centrifugal braking systems.

[0007] U.S. Patent No. 5,108,042 discloses an adjustable, magnetic drag mechanism housed within the left side cover of a right-handed baitcast reel. The mechanism operates by exerting a magnetic drag force on the left end of the reel spool. The magnetic force slows the rotation of the spool during casting. The mechanism comprises a magnet carrier ring having a plurality of

permanent magnets attached thereto, an axially movable cam disc to which the magnet carrier ring is secured, and an adjustment dial projecting through a recess in the left cover. The dial is operatively associated with the cam disc for selectively moving the carrier ring toward and away from the left end of the spool to adjust the amount of magnetic drag force applied to the spool.

[0008] Unfortunately, the amount of drag force imparted by this type of magnetic system does not vary in proportion to the rotational speed of the spool. Rather, for any selected magnet position, the system imparts a constant magnetic dragging force. Thus, for example, when the user has been casting a short distance and then decides to cast a long distance, the user must either adjust the magnetic drag system prior to making the long cast or compensate the magnetic force by applying thumb pressure to the reel spool.

[0009] U.S. Patent No. 5,308,021 discloses a centrifugal braking system commonly used in baitcasting reels. The centrifugal braking system includes a plurality of rod-like members projecting radially from the end of the spool shaft, a plurality of tubular braking pieces or weights slidably mounted on the rod-like members, and a fixed brake ring encompassing the distal ends of the rod-like members. When the spool shaft rotates, the braking pieces move outwardly on the rod-like members into frictional contact with the brake ring. This frictional contact provides a braking force that slows the rotation of the spool.

[0010] The centrifugal braking system desirably exerts a braking force that varies in proportion to the rotational speed of the spool. Unfortunately, however, to make even minor adjustments to the centrifugal system (e.g., to account for the use of a heavier or lighter lure), the left side of the reel must be disassembled and the individual braking pieces must be individually manipulated. Typically, the individual pieces can be snapped into fixed position adjacent the spool shaft whereby the pieces are prevented from sliding into frictional contact with the brake disc. Alternatively, the individual braking pieces can be either replaced or removed.

[0011] In addition to adjustment problems, centrifugal braking assemblies of the type used in USPN 5,308,021 require a relatively large amount of space, are easily damaged (e.g., by bending the rods while making system adjustments), and can easily become unbalanced.

[0012] U.S. Patent No. 5,308,021 discloses a centrifugal braking system wherein the braking force exerted by the system can be selectively adjusted by operating a dial mechanism positioned under the left cover of the reel. Like the standard centrifugal braking system discussed above, the USPN 5,308,021 system utilizes a plurality of individual tubular braking pieces slidably mounted on radial, rod-like members projecting from the end of the spool shaft. However, rather than using a fixed braking ring, the USPN 5,308,021 system employs an axially movable braking structure. Additionally, rather than having a strictly cylindrical braking surface, the USPN 5,308,021 braking structure presents a frusto-conical braking surface that diverges toward a small diameter, cylindrical

braking surface. Further, the roughness of the braking surface varies such that the frictional coefficient presented by the surface increases as the surface is adjusted axially toward the braking elements. Thus, the degree of frictional braking force provided by the USPN 5,308,021 system can be adjusted by changing the point of contact between the braking structure and the braking pieces.

[0013] Unfortunately, the USPN 5,308,021 system uses only a tubular-type braking element assembly and is therefore subject to the same space, damage, and balance problems discussed above. Further, unless the USPN 5,308,021 reel is disassembled and the individual braking elements are either removed or locked into position adjacent to the spool shaft, the USPN 5,308,021 system cannot be adjusted such that the individual braking pieces are completely prevented from contacting any portion of the braking surface. Moreover, the production of a braking surface of the type employed in USPN 5,308,021 having a varying degree of roughness would be both difficult and costly.

[0014] The braking system of USPN 5,308,021 is also likely to produce significant noise problems. Tubular braking elements of the type used in the USPN 5,308,021 system will spin and wear when contacting either an inclined braking surface or a braking surface having a progressively increasing coefficient of friction. Such spinning and wear will likely cause the tubular braking elements to rattle. A substantial amount of rattle will likely also occur when the braking elements frictionally contact the rougher portions of the braking surface.

SUMMARY OF THE INVENTION

[0015] The present invention provides an adjustable braking apparatus and braking element assembly. The braking apparatus and braking element assembly satisfy the needs and alleviate the problems mentioned above. The braking system of the invention provides a proportional braking force that varies in relation to the rotational speed of the reel spool. The braking system of the invention requires less space than previous systems and provides easy adjustment without having to manipulate individual brake elements. Additionally, in the system of the invention, individual braking pieces can be taken completely out of braking position by means of simple adjustment. Further, compared to prior tubular-type braking element assemblies, the inventive braking element assembly is sturdier, more stable, and less susceptible to damage.

[0016] In one aspect, the inventive braking apparatus comprises a contacting structure and a plurality of braking elements for contacting the contacting structure to generate a braking force. A brake element assembly has a brake setting selector that allows a user to control which, if any, braking elements will be permitted to engage the contacting structure, thereby allowing a user to control the braking force. The inventive braking apparatus is further provided with indicia for identifying the brake setting positions.

[0017] Further objects, features, and advantages of the present invention will be apparent to those skilled in the art upon examining the accompanying drawings and upon reading the following description of the preferred embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] FIG. 1 is a partially cutaway, elevational view of a baitcasting reel having the inventive braking apparatus.

[0019] FIG. 2 is a perspective view of the spool assembly of the reel of FIG. 1.

[0020] FIG. 3 is a perspective view of the braking assembly of FIG. 1.

[0021] FIG. 4 is a rear view of the braking assembly of FIG. 1.

[0022] FIG. 5 is an exploded perspective view of the brake assembly of FIG. 1 including brake elements.

[0023] FIG. 6 is a plan view of the brake assembly base, which comprises the brake assembly of FIG. 1.

[0024] FIG. 7 is a rear perspective view of a brake setting selector, which comprises the brake assembly of FIG. 1.

[0025] FIG. 8 is a rear plan view of the brake setting selector, which comprises the brake assembly of FIG. 1.

[0026] FIG. 9 is a perspective view of a brake element of the brake assembly of FIG. 1.

[0027] FIG. 10 is a first exploded perspective view of the right side cover assembly including the contacting structure of the reel of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0028] Depicted in FIG. 1 is a left-handed baitcasting reel 2. Baitcasting reel 2 is a low-profile, contemporary, tear-drop shaped reel including a split frame 4 having a left side plate 6 and a right side plate 8. A line spool 9 is rotatably mounted in frame 4 between side plates 6 and 8. Line spool 9 has a spool end 10 defined thereon. A spool shaft 11 extends through spool 9. A level-wind mechanism 12 traverses spool 9 during winding to ensure that the line is properly wound along the entire length of spool 9. A left side cover 14 is secured over left side plate 6. A crank handle 16 operably extends from left side cover 14 for rotating spool 9. A reel foot 18 is provided on the bottom of frame 4 for attaching reel 2 to a fishing rod. A right side cover 20 is secured over right side plate 8. Braking apparatus 21 is housed within right side cover 20.

[0029] For purposes of example the apparatus of the invention is herein described as incorporated in a left-handed baitcasting reel. However, it should be understood that the apparatus of the invention is equally adaptable for use in right-handed baitcasting reels.

[0030] Braking apparatus **21** preferably includes brake setting selector **24** (FIG. 2) and a brake assembly base **25** (FIG. 2) that form a braking assembly **28** (FIG. 2). Braking assembly **28** retains a plurality of brake elements **34**.

[0031] As depicted most clearly in FIG. 9, each brake element **34** is preferably a T-shaped structure having a longitudinal axis **40**, a wide retaining end **42** and an elongate portion **44** extending from retaining end **42**. A pair of retaining shoulders **46** are defined by the transition from retaining end **42** to elongate portion **44**. Elongate portion **44** has a tapered distal end **47** providing an outwardly projecting brake pad **48**. Each braking element **34** preferably has both a flat forward surface **51** and an opposing flat rearward surface. Flat forward surface **51** is provided with a protruding post **53**.

[0032] As used herein, the terms "forward" and "forwardly facing" describe features facing outwardly away from spool end **10** of line spool **9**. The terms "rearward" and "rearwardly facing," on the other hand, describe features facing toward spool end **10** of line spool **9**.

[0033] Referring now more particularly to FIGs. 3-6, brake assembly base **25** is preferably a substantially cylindrical member having a longitudinal axis of rotation **54** (FIG. 5) a forward face **56** (FIGs. 5, 6) a rearward face **58** (FIG. 4), and a cylindrical outer wall **60**. Snap receptacles **62** extend between forward face **56** and rearward face **58**. Passage **64** is provided to receive spool shaft

11. A plurality of radial slots **68a**, **68b**, **68c**, **68d**, **68e**, and **68f** are provided for slidably receiving brake elements **34**. Brake assembly base **25** further includes a projecting cylinder **65** having an indicator **66** thereon.

[0034] Referring now primarily to FIGs. 5 and 6, radial slots **68a-f** each preferably have forward openings **74** in communication with forward face **56** of brake assembly base **25**. Outer openings **76** are provided in outer wall **60**. Forward openings **74** are substantially T-shaped. Brake elements **34** are slidably received in the T-shaped forward openings **74** for sliding radial movement. Radial slot **68a-f** preferably includes a bottom surface **80**, a narrow radial passage **82** extending into brake assembly base **25** from outer opening **76**, and a wide inner segment **86** communicating with narrow passage **82**. A pair of longitudinally extending interior shoulders **88** are defined by the transition from narrow passage **82** to inner segment **86**. Narrow passages **82** are sized for slidably receiving the elongate portions **44** of brake elements **34**. Inner segments **86** are sized for slidably receiving the wide retaining ends **42** of brake elements **34**.

[0035] Each of slots **68a-f** has a depth defined by the distance from forward face **56** of brake assembly base **25** to the bottom surface **80** of the slot. Slots **68 a-f** are preferably evenly spaced around brake assembly base **25** and are preferably configured such that slot **68a** is diametrically opposed to, and of equal depth with slot **68d**, slot **68b** is diametrically opposed to, and of equal depth

with slot **68e**, slot **68c** is diametrically opposed to, and of equal depth with slot **68f**. Positioning slots **68a-f** in the manner just described ensures balanced rotational operation of brake element assembly **28**.

[0036] Referring now primarily to FIGs. 7 and 8, brake setting selector **24** preferably includes three resilient snap prongs **98** that extend from a rearward face **100** that surrounds central opening **101** of selector **24**. A plurality of radial camming indentations **102** are formed in rearward face **100** of brake setting selector **24**. Preferably, camming indentations **102** are formed in opposite pairs, wherein each pair has a distinct camming characteristic. For example, in the preferred embodiment, as shown in FIGs. 7 and 8, six camming indentations **102** are divided into three opposing pairs of camming indentations **102**, which may be referred to as most restrictive indentation **106**, intermediate restrictive indentation **108** and least restrictive indentation **110**. Forward face **103** (FIG. 5) is preferably provided with indicia **104** located around a perimeter of central opening **101**. Examples of indicia include four settings labeled "Free", "2", "4", and "6".

[0037] Referring now primarily to FIG. 8, most restrictive camming indentations **106** have a curved inner wall **106a** having a constant radius and an outer wall, which varies in distance from longitudinal axis **54**. The outer walls function as a camming surface and have a small radius segment **106b**, a transitional segment **106c**, and a large radius segment **106d**.

[0038] Intermediate restrictive indentations **108** have a curved inner wall **108a** having a constant radius. Intermediate restrictive indentations **108** have an outer wall, which varies in distance from longitudinal axis **54**. The outer walls function as a camming surface and have a small radius segment **108b**, a transitional segment **108c**, and a large radius segment **108d**.

[0039] Least restrictive indentations **110** have a curved inner wall **110a** having a constant radius. Least restrictive indentations **110** have an outer wall, which varies in distance from longitudinal axis **54**. The outer wall functions as a camming surface and has a small radius segment **110b**, a transitional segment **110c**, and a large radius segment **110d**.

[0040] Preferably, inner walls **106a**, **108a**, **110a**, share the same radius of curvature. Additionally, it is preferred that small radius segments **106b**, **108b**, **110b**, and large radius segments **106d**, **108d**, **112d** of the outer walls of indentations **106**, **108**, **110** also share the same radius of curvature.

[0041] Referring now to primarily FIG. 10, a contacting structure or brake ring assembly **114** is affixed to an inside surface of right side cover **20**. Brake ring assembly **114** preferably includes a base member **115**, a brake ring housing **116**, a spool shaft bearing **118** and a brake ring **120**. A contacting structure, such as brake ring **120** is received within brake ring housing **116**. Brake ring **120** is preferably constructed of metal and closely surrounds braking assembly **28** when right side

cover **20** is secured to frame **4** of reel **2**, as shown in FIG. 1. Brake ring **120** is positioned to receive selective engagement with brake elements **34**. Spool shaft bearing **118** is secured within brake ring housing **116** with retainer spring **122**. Spool shaft bearing **118** receives an end of spool shaft **11**.

[0042] In use, brake assembly **28** operably retains brake elements **34** in the radial slots **68a-f** of brake assembly base **25**. Brake assembly base **25** is attached to spool end **10** of spool **9** as shown in FIG. 2. Brake assembly base **25**, therefore, rotates with spool **9**. When secured to spool **9**, the rotational axis **54** of braking assembly **28** is collinear with the rotational axis of spool **9**. Brake setting selector **24** is rotatably attached to brake assembly base **25** by snapping resilient snap prongs **98** (FIG. 7) into snap receptacles **62** (FIGs. 5, 6) of brake assembly base **25**.

[0043] Brake elements **34** are retained within radial slots **68a-f** of brake assembly base **25** by rearward face **100** of brake setting selector **24**. Posts **53**, which protrude from flat forward surface **51** of brake elements **34**, are received within camming indentations **102** (FIGs. 7 and 8), formed on rearward face **100** of brake setting selector **24**.

[0044] When braking assembly **28** rotates with spool **9**, the resulting centrifugal force imparted to brake elements **34** urges brake elements **34** to slide radially outward in slots **68** away from axis **54**. Braking elements **34** are sized such that, at least when elements **34** slide into their outermost radial positions, brake elements **34** project from braking assembly **28** through the outer

openings **76** formed in outer wall **60** of brake assembly base **25**. In a preferred embodiment of the inventive braking apparatus, brake elements **34** project from openings **76** to operably interact with brake ring assembly **120** (FIGs.1, 10).

[0045] The outward, radial braking movement of brake elements **34** away from longitudinal axis **54** is limited either by the abutment of brake element retaining shoulders **46** with shoulders **88** of radial slots **68** or by contact of brake pad **48** of brake element **34** with brake ring **120**. When radially extended, brake elements **34** engage brake ring **120** to provide braking action.

[0046] Selected brake elements **34** may be restrained from radial braking movement by positioning brake setting selector **24** in a desired position. When brake setting selector **24** and brake assembly base **36** are assembled to form brake element assembly **28**, camming indentations **102** (FIGs. 7, 8) on the brake setting selector **24** are positioned relative to radial slots **68a-f** such that posts **53** of brake elements **34** extend past the rearward face **100** of brake setting selector **24** and into the camming indentations **102**.

[0047] By selectively orienting the brake setting selector **24** in a desired rotational orientation with respect to the brake assembly base **25**, the brake elements **34** are selectively allowed full radial travel or are restricted from full radial travel, i.e., selected brake elements **34** are either permitted to move radially outward within slots **68** to make contact with brake ring **120** or not. By

allowing all of the brake elements **34** to move outwardly and contact brake ring **120**, maximum braking is achieved. By allowing a selected fewer number of brake elements **34** to contact brake ring **120**, a controlled lesser amount of braking may be achieved.

[0048] Turning now to FIGs. 3 and 8, a selected amount of braking may be achieved as follows. As set forth above, when brake assembly base **25** and brake setting selector **24** are assembled to form braking assembly **28**, posts **53** (FIG. 9) of brake elements **34** protrude into camming indentations **102**, e.g., most restrictive camming indentation **106**, intermediate restrictive camming indentation **108**, and least restrictive camming indentation **110**. When brake setting selector **24** is positioned in the “free” position, each of posts **53** are located on radial lines L_r (FIG. 8) that intersect large radius segments **106d**, **108d**, **110d**. Posts **53** may travel from a first position in contact with inner walls **106a**, **108a**, **110a** to a position adjacent large radius segments **106d**, **108d**, **110d**, i.e., posts **53** are allowed a maximum distance of travel, thereby permitting all of braking elements **34** to fully extend outwardly from outer wall **60** of brake assembly base **25**.

[0049] Referring back to FIG. 3, when brake setting selector **24** is rotated to a second position, e.g., when indicator **66** is aligned with indicia **104** indicating “2”, brake element posts **53** that extend into camming indentations **108** and **110** are located on radial lines L_2 (FIG. 8) that intersect large radius segments **108d**, **110d** of intermediate restrictive camming indentation **108** and

least restrictive camming indentation **110**. Posts **53** that extend into most restrictive camming indentations **106** are located on radial line L_2 intersect small radius segments **106b**. Therefore, posts **53** in intermediate restrictive indentations **108** and least restrictive indentations **110** may travel from a first position adjacent inner wall **108a**, **110a** to a position adjacent large radius segments **108d**, **110d**, i.e., posts **53** are allowed a maximum distance of travel, thereby permitting these braking elements **34** to fully extend outwardly from outer wall **60** of brake assembly base **25** to contact brake ring **120**. However, posts **53** in most restrictive camming indentations **106** may only travel from a first position in contact with inner wall **106a** to a position adjacent small radius segments **106b**, i.e., these posts **53** are allowed little or no distance of travel, thereby prohibiting these braking elements **34** from fully extending outwardly to contact brake ring **120**.

[0050] Referring back to FIG. 3, when brake setting selector **24** is rotated to a third position, e.g., when indicator **66** is aligned with indicia **104** indicating “4”, brake element posts **53** that extend into least restrictive indentations **110** are located on radial lines L_4 (FIG. 8) that intersects large radius segments **110d** of least restrictive camming indentation **110**. Posts **53** that extend into intermediate camming indentations **108** and most restrictive camming indentations **106** are located on radial lines L_4 that intersect small radius segments **106b**, **108b**. Therefore, posts **53** in least restrictive indentations **110** may travel from a first position in contact with inner wall **110a** to a

position adjacent large radius segments **110d**, i.e., posts **53** are allowed a maximum distance of travel, thereby permitting these braking elements **34** to fully extend outwardly from outer wall **60** of brake assembly base **25** to contact brake ring **120**. However, posts **53** in intermediate restrictive indentations **108** and most restrictive camming indentations **106** may travel from a first position in contact with inner wall **106a**, **108a** to a position adjacent small radius segments **106b**, **108b**, i.e., posts **53** are allowed little or no distance of travel, thereby prohibiting these braking elements **34** from contacting brake ring **120**.

[0051] Referring back to FIG. 3, when brake setting selector **24** may be rotated to a fourth position, e.g., when indicator **66** is aligned with indicia **104** indicating "6", posts **53** that extend into camming indentations **106**, **108**, and **110** are located on radial lines L_6 (FIG. 8) that intersect small radius segments **106b**, **108b**, **110b**. Therefore, posts **53** in least restrictive indentations **110**, intermediate restrictive indentations **108** and most restrictive indentations **106** may travel from a first position in contact with inner walls **106a**, **108a**, **110a** to a position adjacent small radius segments **106b**, **108b**, **110b**, i.e., all posts **53** are allowed little or no distance of travel, thereby prohibiting any braking elements **34** from contacting brake ring **120**.

[0052] In summary, it can be seen that when brake setting selector **24** is rotated to a first position, all of brake elements **34** are permitted to fully extend to engage brake ring **120** for braking

action. When brake setting selector **24** is rotated to a second position, only four of the six brake elements **34** are permitted to fully extend to engage brake ring **120** for braking action. When brake setting selector **24** is rotated to a third position, only two of the six brake elements **34** are permitted to fully extend to engage brake ring **120** for braking action. Finally, when brake selector **24** is rotated to a fourth position, none of the six brake elements **34** are permitted to fully extend to engage brake ring **120** for braking action. Therefore, by adjusting the brake setting selector **24** as desired, a user may control resistance to rotation of spool **9** during casting by controlling the number of braking elements **34** that may extend to contact brake ring **120** for providing braking action.

[0053] Although three pairs of camming indentations **102** and six braking elements **34** are shown in the exemplary embodiment, it should be understood that greater or fewer of both camming indentations **102** and braking elements **34** may be provided, depending on the degree of control that is desired. Additionally, although pairs of camming indentations **102** having similar outer surface camming profiles are provided, braking element assemblies **28** are contemplated that have individually distinct camming characteristics. Further, it may be desirable to group camming indentation **102** into groups where three or more camming indentations **102** are the same.

[0054] As will be understood by those skilled in the art, although the inventive braking element assembly **28** is preferred, other types of braking element assemblies (e.g., radially extending

rods having braking weights, pads, and/or bristles slidably mounted thereon) could be used in the inventive braking apparatus. In addition, although the embodiment disclosed herein is shown as incorporated in a contemporary, low-profile baitcasting reel, it will be understood by those skilled in the art that the inventive apparatus can be employed in traditional baitcasting reels or generally any other type of baitcasting reel.

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[0055] Thus, the present invention is well adapted to carry out the objects and attain the ends and advantages mentioned above as well as those inherent therein. While presently preferred embodiments have been described for purposes of this disclosure, numerous changes and modifications will be apparent to those skilled in the art. Such changes and modifications are encompassed within the spirit of this invention as defined by the appended claims.